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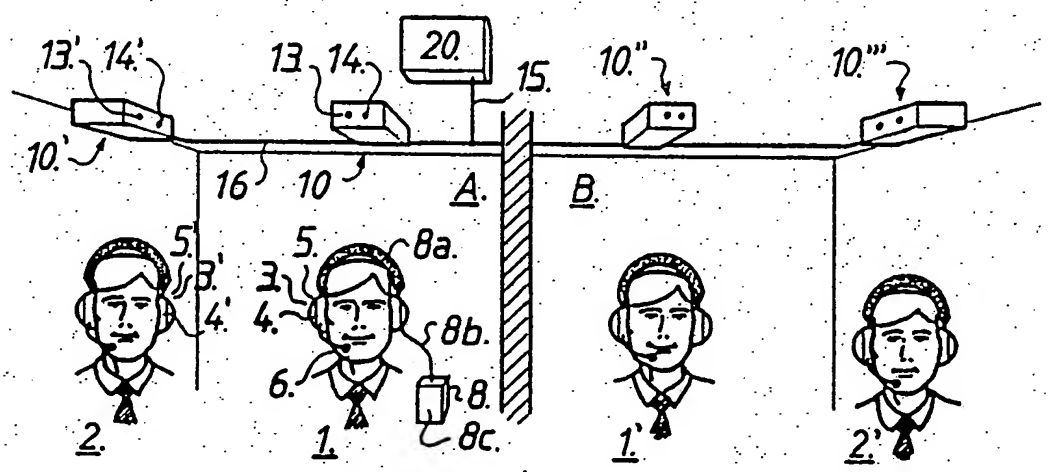

(57) Abstract

The invention relates to a cordless communication system for the transmission of information between at least two units (1, 2), of which one unit (1) is equipped with one or more light-emitting diodes (3), preferably diodes adapted to generate infrared light (IR-light), and the other unit (2) is equipped with one or more photodetectors (5), preferably adapted to receive IR-light. One of the units also includes means for modulating the light generated by the light-emitting diodes in dependence on the desired information content, and the other unit is provided with means for interpreting the received modulated light signal in order to obtain the prevailing information content. The means of one unit (1) is intended to form, via respective diodes (3), a light change which corresponds to a continuous function. The modulation for information transmission conforms to the principles of frequency modulation and/or amplitude modulation, and the means of the other unit (2) evaluates the prevailing light change and/or frequency change. Each unit (1) includes a switch device (8c) which is able to alternate frequencies, one frequency being intended for internal communication (1, 2) and one intended for external communication (1, 1' and 1, 2' respectively).

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CORDLESS COMMUNICATION SYSTEM

TECHNICAL FIELD

The present invention relates to a cordless communication system for transmitting information between at least two units, of which one unit is equipped with one or more light-emitting diodes, preferably diodes designed to generate infrared light (IR-light), and the other unit is equipped with one or more photodetectors, preferably detectors which are adapted for receiving IR-light.

One of said units is also equipped with means for modulating the light produced through said light-emitting diodes, in dependence on the desired information content, and the other of said units is equipped with means for interpreting the modulation of the transmitted modulated light, so as to obtain the prevailing information content, such as speech content.

The single path communication which can be achieved between the two units can be readily extended to a two-way communication system, by also equipping the one unit with photodetectors and the other unit with light-emitting diodes in a manner known per se.

Cordless communication is normally effected with the aid of electromagnetic radio waves. In the case of applications where this transmission technique is excluded because of undesired disturbing radiation, there have been developed possibilities of transmitting information with the aid of light signals, acoustic

signals, inductive (magnetic) transmission and capacitive (electric) transmission.

The present invention relates to a communication system which utilizes light-emitting diodes to produce light signals, which are modulated for the purpose of transmitting information, and photodetectors, for instance silicon diodes (PIN-diodes), for the purpose of receiving the information thus transmitted.

These light-emitting-diode components are primarily used because they are able to transmit light within the infrared range, wave lengths within the range of 800-1300 microns, and afford the highest efficiency within this infrared range.

The present invention is thus based on a cordless communication system which uses light signals within the visible and/or the infrared range, the light intensity of which varies with time, and has been developed particulary to ensure that speech information can be transmitted readily and positively in a noisy environment between personnel located primarily in a defined space where cable-dependent main microtelephones adapted for two-way communication cannot be used for safety reasons, among other things.

The inventive communication system does not only enable information to be exchanged readily and simply between personnel located in a defined space, but also enables information to be exchanged in a ready fashion between personnel located outside said space, where these latter personnel can also use a standard interwork system.

BACKGROUND ART

There are known to the art several different types of cordless communication systems which operate within the infrared range and use light-emitting diodes or transmitting light pulses which have been modulated in accordance with their information content, photodetectors and circuits connected to said detectors and operative to interpret the information contained in the modulated light pulses and therewith obtain the speech information content concerned.

Such cordless communication systems are used in conjunction with receiver headsets or headphones for receiving speech transmitted from television and radio apparatus and also for transmitting information in the classroom and in the conference room.

Such systems have also been proposed for the remote control of television apparatus, models and like technical devices.

These systems use generally available light-emitting diodes having a low light intensity, at least when in continuous use, and a correspondingly short range.

With the intention of extending the range of the light pulse produced by the diode, however, it has been proposed that the diode is overloaded very briefly, so that the diode will produce a short, highly intensive light pulse over this time period, and to extinguish the diode over time periods between consecutive pulses. The duration of the light pulses is normally shorter than the duration of the extinguished period.

Naturally, the production of intensive light pulses of short duration requires corresponding modulation of the information content. This modulation is effected by modifying the extinguished time distance between two sequential light pulses.

The transmission of intensive pulses of short duration and modulation of the light pulses according to information content implies certain limitations on the receiver side, however, since the detection of these light pulses requires a wide bandwidth if these pulses are to be perceived and distinguished from ambient stray light.

The earlier standpoint of techniques includes the teachings of German Offenlegungsschriften 29 20 208, which illustrates a receiver for modulated light within the visible and/or the infrared range. This receiver has the form of a light-responsive receiver diode which is connected in a particular manner to associated amplifying, controlling and detecting means, and a control circuit belonging to the receiver.

In order to achieve an improved relationship with the disturbance level, the performance radiation is subjected to intensity modulation of an amplitude modulated carrier wave, which modulates the frequency of the information carrying signal.

In this case, the carrier wave frequency shall deviate greatly from the modulation frequency of the disturbance source (for instance fluorescence lamps and neon lamps).

The subject matter of German Offenlegungsschriften 28 37 907 also belongs to the prior art. This publication teaches a method of transmitting low frequency signals between electrooptical transmitting and receiving devices with the aid of amplitude modulated optical radiation, such as IR-light.

A communication system which utilizes IR-light is also known from European Patent Application 79 20 0538 (Publication No. 0 009 295).

The German Offenlegungsschriften 36 07 885, the International Patent Application PCT/US83/00013 (Publication No. WO83/04462) and the German Auslegeschriften 25 59 646 can also be said to belong to the prior state of techniques.

DISCLOSURE OF THE INVENTION

TECHNICAL PROBLEMS

When reviewing the prior art as described in the foregoing, it will be seen that a technical problem resides in creating modulation appropriate for IR-light transmission with the aid of simple means, such that the infrared light transmitted through the light-emitting diode can be readily received by the photodetector and by equipment connected thereto, which with the use of a narrow bandwidth, say a bandwidth of 5 to 15 kHz, is able to receive the light pulses and detect said pulses despite troublesome background light noise, and therewith realize that it is possible to create conditions conditions which will enable the photodetector to detect signals which are transmitted from several transmitters simultaneously, when said transmitters are

intended to transmit at slightly different fundamental frequencies, by causing a light-emitting diode to transmit light signals corresponding to a continuous function and modulating the information carrying signals in accordance with known principles, such as the principles of frequency modulation or amplitude modulation.

It will also be seen that another technical problem resides in creating a cordless communication system based on IR-light transmissions which will not only maintain information transmission through speech channels between persons provided with appropriate equipment, or data via terminals, in a simple and effective manner, but which can also create conditions which will enable such a communication system to be connected to a permanent installation and therewith afford telecommunication with persons in another defined space.

It will also be seen that a technical problem resides in realizing those simplifications that can be achieved in the transmitting and receiving system when modulation of the IR-light for the transmission of speech or data information is based on known modulating principles, such as the frequency modulation of sinusoidal light signals.

It will also be seen that a further technical problem is one of creating conditions, with the aid of simple means, which will enable a communication system intended for speech communication between two people in a defined space can be caused to coact with a fixed installation.

One qualified technical problem resides in realizing the advantages that are afforded by selecting a small range for the transmission of information over portable equipment, with lower power consumption and longer operational times of the drive batteries used, and by choosing a higher power input for a permanent installation which has access to heavy current supply.

In this regard, it is particularly suitable to connect a few powerful transmitters and a plurality (many) of receivers in the fixed installation.

In addition, a qualified technical problem is one of realizing the advantages that are afforded by being able to control the transmission power or receiver response for information transmission over a short range, for instance a range of about 4 metres, which can actually enable information to be transmitted between different groups or between different participants of a conference on the same modulation principle, if they are just located outside the range of such groups.

It will also be seen that a technical problem resides in creating simple conditions for obtaining an effectively working communication system with a narrow bandwidth without jeopardizing transmission sensitivity.

Another technical problem resides in selecting a bandwidth which is so narrow as to provide the requisite number of channels.

Another technical problem is one of providing a bandwidth which is so narrow as to enable the transmission

to be made selectively on several channels or frequencies (250, 340....kHz).

Another technical problem is one of realizing the significance of using simple repeaters or rod transmission techniques and to be able to re-transmit those signals which have been received on one frequency (250 kHz) on a different frequency (340 kHz).

Aother qualified technical problem resides in realizing that the principles utilized within radio technology can also be used within IR-technology.

SOLUTION

For the purpose of solving one or more of the aforesaid technical problems, the present invention relates to a cordless communication system which is based on known characteristics and suppositions for the transmission of IR-light to a receiver in a modulated state, and having the characteristic features set forth in the preamble of Claim 1.

According to the present invention, a switch included in one of said units can be caused to take either one of two positions, the one switch position being intended for the transmission of information between two closely located units and the other switch position being intended for the transmission of information between two remotely located units.

According to proposed embodiments lying within the scope of the invention, when the switch is in said one position, information is transmitted at a first modulation frequency (340 kHz) whereas when the switch is in the other switch position, information is transmitted

at a second modulation frequency (250 kHz).

The first modulation frequency is higher than the second modulation frequency.

According to one embodiment of the invention, the first and the second units are carried on or worn by the operator concerned and include a receiver headset and microphone, and light-emitting diodes and photodetectors are mounted on the outer surface of the headsets so as to enable two-way communication between two persons located close to one another.

In accordance with a further development of the invention, a third unit is fixedly installed in the defined space and is provided with a plurality of mutually connected light-emitting diodes and a plurality of mutually connected photodetectors, each facing towards different sections of the space, so as to make possible two-way communcation between persons located in separate spaces or rooms.

It also lies within the scope of the invention to provide the third unit with a group of light-emitting IR-diodes and to provide a larger number of light receivers (PIN-diodes) as separate units connected physically to the third unit by means of cables.

An advantage is afforded when the third unit is constructed to coact with a central unit.

According to one embodiment of the invention, the microphone is connected to a microphone amplifier and a generator which is adapted for modulation and on the output of which there is produced sinus oscillation

which is modulated in accordance with the speech taken up via the microphone and applied to series-connected light-emitting diodes.

The photodetector is connected to a receiver which includes a receiver circuit and an amplifier for headset or loudspeaker operation.

The generator is adapted to transmit over one of a number of available channels of different fundamental frequency.

The third unit is connected to a central unit by means of cables and the receiver is downstream connected to a current negative feedback connected amplifier.

There is also provided the possibility of connecting the central unit to a telephone system, this connection being a two-wire or a four-wire interface connection.

Finally, the bandwidth used is selected from between 5 and 15 kHz, preferalby about 10 kHz.

ADVANTAGES

Those advantages afforded by the inventive cordless communication system reside in the possibilities of controlling continuously the variations in the intensity of the light transmitted by the light-emitting diode such that these variations will form a continuous light change and therewith enable light detection and evaluation of the information content of the light variation to be effected in receivers of smaller bandwidth than in earlier proposed light transmitting systems, by selecting modulation so that it conforms

with the principles of frequency modulation and/or amplitude modulation. This enables known components to be used in the transmitter and receiver units, therewith simplifying the interconnection of the communication system. The receivers are preferably selective and capable of distinguishing a signal of specific fundamental frequency from other signals of other fundamental frequencies.

The inventive system also enables switching between different carrier frequencies to be effected in a simple fashion, therewith enabling information to be transmitted between several people in one and the same system.

The main characterizing features of an inventive cordless communication system are set forth in the characterizing clause of the following Claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

An inventive cordless communication system incorporating significant characteristic features of the present invention will now be described in more detail with reference to the accompanying drawings, in which

Figure 1 illustrates a suggested application of the inventive communication system;

Figure 2 illustrates at "A" a known first modulating method and at "B" a known second modulating method which conforms with the modulating

method applied in accordance with the invention;

Figure 3 is a block diagram illustrating part of the equipment belonging to a portable unit;

Figure 4 is a block diagram illustrating a complementary part of the portable equipment illustrated in Figure 3;

Figure 5 is a block diagram which illustrates a permanently installed unit; and

Figure 6 is a block diagram which illustrates a central unit.

DESCRIPTION OF EMBODIMENTS AT PRESENT PREFERRED

Figure 1 illustrates a cordless communication system between two units referenced 1 and 2. These units are mutually identical and in the following, the communication system is illustrated by the transmission of information (speech) from one unit 1 to the other unit 2 with the aid of modulated IR-light signals, said second unit being provided with message receiving means.

It will be understood that in a two-way communication system, the units 1 and 2 will both be equipped with IR-transmitters and IR-receivers.

Since the two units are identical, the reference signs used to identify the components of unit 1 have also been used to identify corresponding components of unit 2, although supplemented with a prime sign (for instance 3 and 3′ respectively).

It will also be seen from Figure 1, the two units 1 and 2, each manned by a separate operator, are located

relatively close to one another in a wall-defined space "A", and that two units 1′ and 2′, each manned by a separate operator, are located close to one another in a further, adjoining defined space "B".

The units 1′ and 2′ are able to communicate with one another in the same way as the units 1 and 2.

Furthermore, each unit 1 and 2 is able to communicate with respective units 1′ and 2′, or vice versa, via a fixed installation, as described in more detail here below.

Although the principles of both amplitude modulation and frequency modulation may be applied, the following description will be made with reference to frequency modulation, for the sake of simplicity.

The following description will include primarily solely the unit 1.

The unit 1 is provided with a plurality of light-emitting diodes 3, for instance eight diodes, which are distributed on the outer surface of a receiver headset which is worn by the operator, and a headphone 4 which is attached to the outer surface of the headset or in the vicinity thereof. A photodetector 5 is positioned adjacent each diode.

Although the selected positions and orientation of the diodes 3 and the photodetectors 5 have not been shown, it will be understood that said diodes and detectors shall be appropriately distributed on the outer surface of the headset.

Each of the diodes 3 is series connected and adapted to produce infrared (IR-light) through time-dependent current supply, and the second unit 2 is provided with one or more photodetectors 5' adapted to receive transmitted IR-light.

Each receiver diode (PIN-diode) 5' is connected to an input stage, the output of which has a circuit which is tuned to the desired signal frequency. Alternatively, the PIN-diode may supply the tuned circuit directly, so as to select-out effectively disturbance signals such as light noise (sunlight).

The one unit 1 is also provided with means for modulating the light signal via said light-emitting diodes 3 in accordance with desired information content (speech content), and the other unit 2 is provided with means which, upon receipt of the modulated light signal, interpret said modulation for transmission of the prevailing information content through a headphone or loudspeaker.

The first and the second unit 2 each comprise a unit carried by the operator and including receiver headset 4, microphone 6 and both light-emitting diodes 3 and photodetectors 5 mounted on the outer surface of the headsets and distributed and positioned so that the diodes 3 are unable to influence adjacent photodetectors 5 but are able to influence one or more of the photodetectors 5' of the other unit 2.

This latter feature is not necessary per se when transmission and reception are effected in accordance with simplex-operation, since in this case transmission and reception are effected alternately.

The unit 1 comprises an upper part 8a which is worn on the head of the operator and which includes a microphone 6 and receiver headset 4 incorporated in a casing whose outer surface carries light-emitting diodes and photodetectors, a connecting cable 8b, and a lower part 8 which includes a battery holder, among other things.

Each unit 1 is provided with a two-position switch 8c. When switched to one of said positions, information can be transmitted between two closely located units 1, 2 or 1', 2' respectively. When switched to the other of said positions, information can be transmitted between two remotely located units, for instance unit 1 and unit 2', via a permanently connected network.

The switch is constructed to select in one switch position a modulating frequency or carrier frequency which is different to the modulation frequency or carrier frequency for which the other switch position is operative. These frequencies may be 340 kHz and 250 kHz respectively.

The cordless communication system also includes a third unit 10 which is permanently installed in a defined space A and which is provided with light-emitting diodes and photodetectors which face towards different parts of the space or room concerned.

For the sake of simplicity, only one light-emitting diode 13 and only one photodetector 14 has been shown for the unit 10 and only one light-emitting diode 13' and one photodetector 14' has been shown for a further unit 10', although it will be understood that these permanent units 10 and 10' respectively may be provided

with several such diodes and detectors in order to cover different parts of the space or room and therewith positively receive the light transmitted from the unit 1, said unit 1 being connected with a cable-bound system.

Each of the three units 10, 10' coacts with a central unit 20 via a bundle of lines 15. The units 10, 10' are connected with one another by means of a line bundle 16.

As an alternative to the above, solely the light-emitting diodes 13 may be fixedly mounted on the third unit and a plurality of photodetectors may be distributed within the space or room in the form of separate units. This is beneficial when powerful light transmitters or light-emitting diodes 13 are used in the unit 10 and weaker light transmitters or light-emitting diodes are used in the equipment worn by the operators.

In order to obtain a better understanding of the following description, it should be noted that the unit 1 is divided-up, such that certain components are mounted in the receiver headset 4 while other components are mounted in the lower part 8 of the unit, and that the upper part 8a and the lower part 8 of the unit are connected together by means of a physical cable 8b.

Figure 2 illustrates schematically the principle difference between two modulating methods.

In Figure 2a, the reference "a" indicates the generation of infrared light in the form of short, intensive light pulses 3a where a high light intensity is chosen due to a conscious overcurrent and brief overload of

the light-emitting diode. In this case, modulation of the speech transmission is effected by varying the "black" or extinguished time distance "tl" between sequential pulses 3a, 3a'. This method of modulation is earlier used in a cordless communication system based on IR-light.

Such brief light impulses produced by means of over-currents of short duration result in a long range, but the intensity of the light and the short duration of the pulses in relation to the "black" time distance (t_1) places special requirements on the receiver.

It is known that detection of such brief high energy pulses requires a wide bandwidth on the photodetector, as illustrated to the right in Figure 2.

According to the method referenced "b" in Figure 2, the unit is provided with means which form, via respective light-emitting diodes, a sinusoidal function which is simplified to a continuous function and which corresponds to a light change 3b, therewith enabling modulation for information transmission to conform to the principles of frequency modulation with a narrow bandwidth.

Accordingly, the second unit includes means for evaluating the light change and the frequency change, which can be effected at a much narrower bandwidth, as illustrated to the right in Figure 2.

A detector which operates at a bandwidth as narrow as 10 kHz for evaluating the information content of a transmitted IR-light variation could also be used, at the same time, to receive IR-light variations from

other transmitters.

Thus, it is possible to receive signals selectively from one transmitter and shut out other transmitters. The transmitter would be able to listen on a number of channels and exclude remaining channels.

Figure 3 is a block diagram which illustrates in a very simple fashion the lower part 8 of the portable equipment illustrated in Figure 1, the microphone 6 of said illustration being connected to connection 31.

The microphone 6 is connected to a microphone amplifier 32 with compressor, this amplifier being connected in turn to a generator 33 which is adapted for frequency modulation and which can be switched between two (or preferably more) available carrier frequencies by means of a switch device 33a (8c). The frequency modulated sinus oscillation generated by the prevailing speech, through the microphone 6, occurs on the line 33b which, in the Figure 4 embodiment, is connected by means of a drive stage 34 to a number of series-connected light-emitting diodes 3 which produce a light intensity corresponding to the light intensity illustrated in Figure 2b, i.e. a frequency modulated IR-light beam.

Activation of either the receiver 44 or the transmitter 33 is controlled by a switch device 35 which is controlled by signals on the line 32a. A high signal on the line 32a cuts-off the receiver 44.

The photodetectors 5' (Figure 4) of the unit 2 receive the light signals produced by the light-emitting diodes 3. These signals are delivered to a summation circuit 41, a tuning circuit 42 and an output amplifier 43, and

are then delivered to a receiver 14 (Figure 3) on the line 43a.

The receiver 44 may essentially comprise an FM-receiver and a local oscillator 45 and transmits the information content of the signal to a loudspeaker or receiver headset on the line 46a, via an amplifying stage 46.

It is now possible for the unit 1 to transmit speech to the unit 2, and similarly for the unit 2 to transmit speech to the unit 1.

An extended communication system, however, also includes units which are permanently installed in the defined space or room 7, these units 10 also being provided with light-emitting diodes 13 and photodetectors 14 for transmitting and receiving light signals.

Figure 5 is a block diagram illustrating the unit 10 in which light-emitting diodes 13 are oriented as light transmitters, the information content of the diodes being delivered over a power amplifier 51 from a central unit 20 on lines 51a.

The unit 10 also includes a receiver 52 having photodetectors 14 connected thereto. The receiver 52 sends via a feedback amplifier 53, the signal on said line with high impedance, in order to enable a large number of similar receivers 52 to be connected to the line 53a without loading it leading to the central unit 20.

Figure 6 is a block diagram illustrating the central unit 20, which includes a receiver 62 and a transmitter 63. The receiver may include a requisite amplifier for

delivering the information content to a telephone line 62a.

The invention has been illustrated, to a large extent, in the form of block diagrams, which is considered sufficient for one of normal skill in this art to practice the inventive principles.

It will be noted, however, that the following standard units can be included in the illustrated blocks.

Microphone Amplifier 32	SL6270C
Frequency Modulator 33	XR2206
Receiver 44	TDA 7000

There is a wide variation of choice with respect to remaining blocks.

The fundamental frequency of the generator 33 can be switched between 250 and 340 kHz by means of the switch device 33a.

It is assumed that the units 1 and 2 transmit on frequency 340 kHz between one another. Respective units are able to communicate with the permanent installation on frequency 250 kHz, through the unit 10.

The unit 10 can transmit on frequency 340 kHz.

Thus, each unit 1 and 2 can switch from internal message transmission to transmission to the permanent installation.

Although the invention has been described with reference to frequency modulation, it is possible to modu-

late the amplitudes of the signals in a known manner.

In this respect, it is suggested that there is used frequency multiplex with simple sideband and suppressed carrier wave, for instance of the kind described and illustrated in Swedish Patent Specification 441 885.

With regard to the selected bandwidth, this bandwidth is preferably not lower than about 5 kHz, since sensitivity is then reduced to acceptable levels. Neither should the bandwidth be higher than 15 kHz, since a bandwidth of such high magnitude limits the number of available channels.

The invention is not restricted to the aforedescribed and illustrated embodiment, since modifications can be made within the scope of the inventive concept as defined in the following Claims.

CLAIMS

1. A cordless communication system between at least two units (1, 2 and 1, 2′ respectively), where one unit (1) is provided with one or more light-emitting diodes (3), preferably diodes adapted for generating infrared light (IR-light), and the other unit is provided with one or more photodetectors (5), preferably adapted for receiving IR-light, in which one said unit (1) also includes means for modulating the light generated by said light diodes (3) in dependence on desired information content, and the other unit includes means for interpretating the modulation of the modulated light signal transmitted in order to obtain the prevailing information content, wherein the means of one unit is intended to form, via respective light-emitting diodes, a light change corresponding to a continuous function, wherein modulation for information transmission conforms to the principles of frequency modulation and/or amplitude modulation, and wherein the means of said other unit is intended to evaluate occurrent light changes and/or frequency changes and interpret the information obtained thereby, c h a r a c - t e r i z e d in that the one unit (1) includes a switch device (8c) capable of being activated to one of two positions, the one position being intended for the transmission of information between two closely located first (1) and second (2) units, and the other position being intended for the transmission of information between two remotely located units, namely the unit (1) and a second unit (2′) located remotely from said first unit, via a permanently installed network.

2. A system according to Claim 1, c h a r a c -

t e r i z e d in that in one switch position, information is transmitted at a first frequency (340 kHz) and in the other switch position, information is transmitted at a second frequency (250 kHz).

3. A system according to Claim 2, c h a r a c - t e r i z e d in that the first frequency is higher than the second frequency.

4. A system according to Claim 1, c h a r a c - t e r i z e d in that a first unit (1) and a second unit (2) comprise a receiver headset and microphone unit intended to be worn by the operator and including light-emitting diodes and photodetectors disposed on the headsets for two-way communication by two persons located close to one another.

5. A system according to Claim 1, c h a r a c - t e r i z e d by a third unit (10) which is permanently installed in a defined space (A) and comprising light-emitting diodes and photodetectors which face towards different sections of said space for two-way communication between two people (1, 2) located in a defined space or two-way communication between people (1, 2) located in mutually separated spaces.

6. A system according to Claim 5, c h a r a c - t e r i z e d in that the third unit (10) coacts with a central unit (20).

7. A system according to Claim 5 or 6, c h a r a c - t e r i z e d in that said third unit is connected physically by cables to a central unit; and in that the receiver is downstream connected to a current negative feedback amplifier.

8. A system according to Claim 6, c h a r a c - t e r i z e d in that the central unit (20) is connected to a telephone system.

9. A system according to Claim 1 or 2, c h a r a c - t e r i z e d in that bandwidth is between 5 and 15 kHz, preferably about 10 kHz.

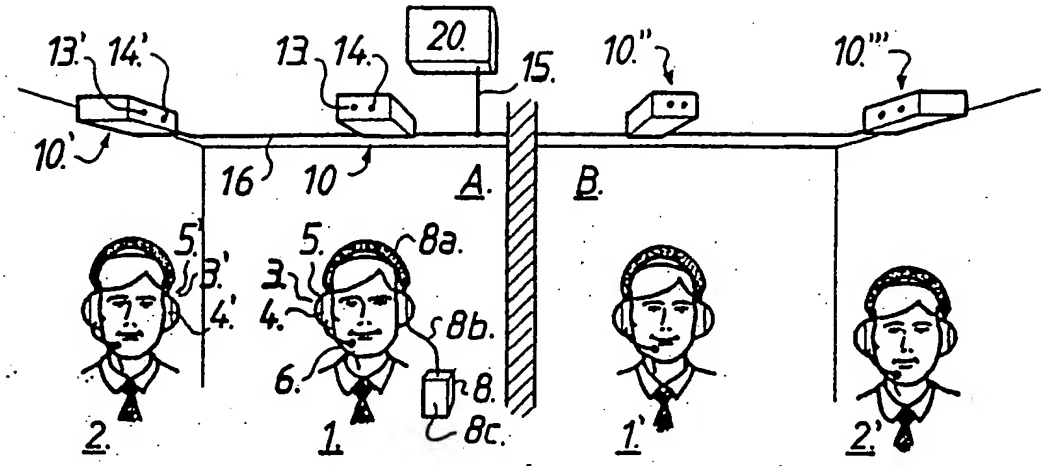

Fig 1.V

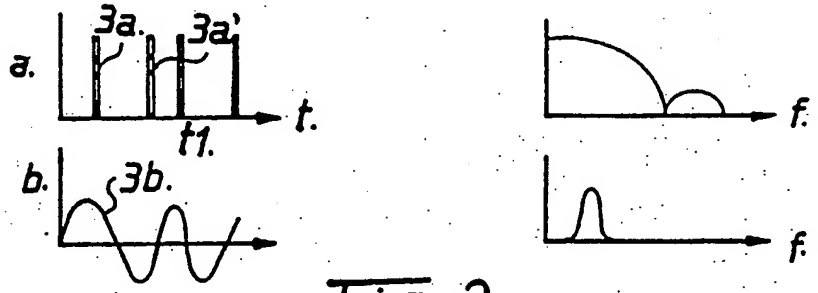

Fig 2.

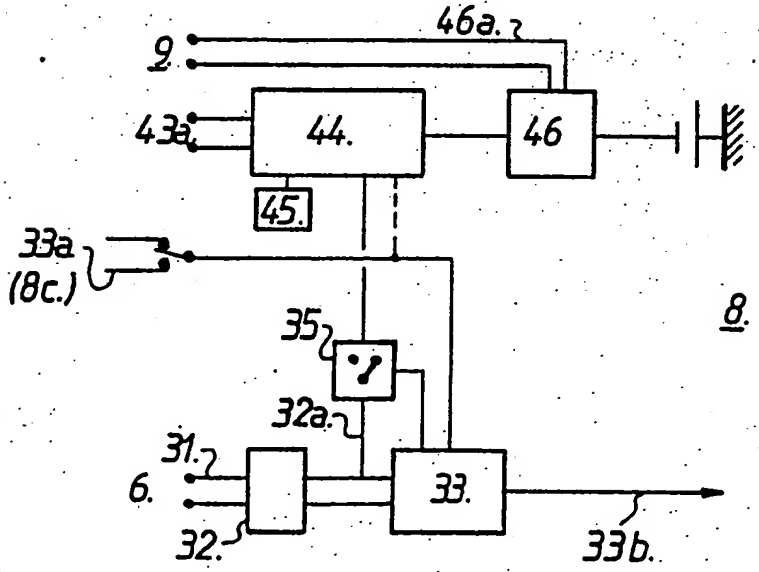

Fig 3.

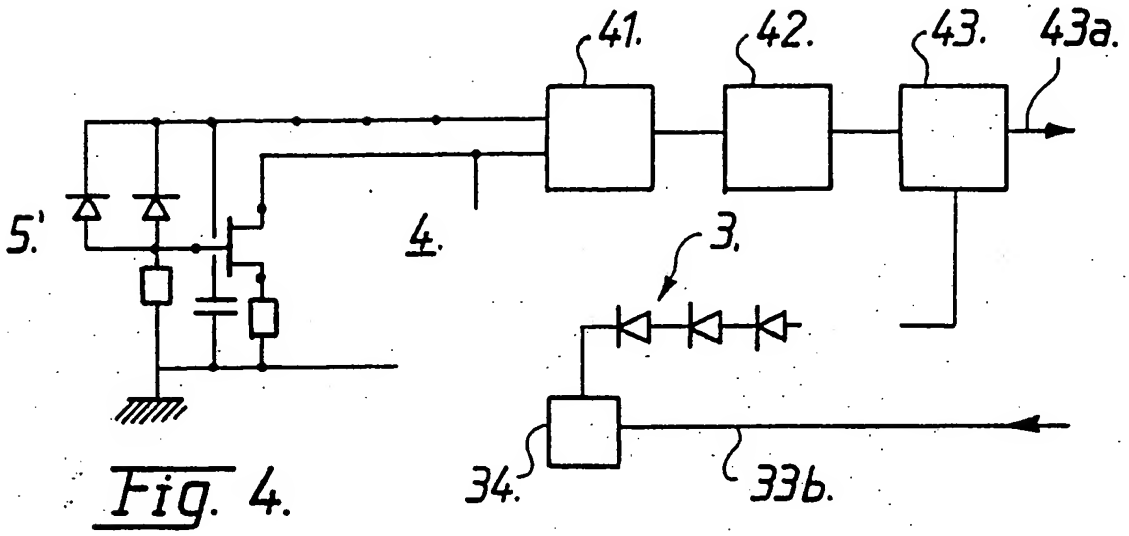

Fig. 4.

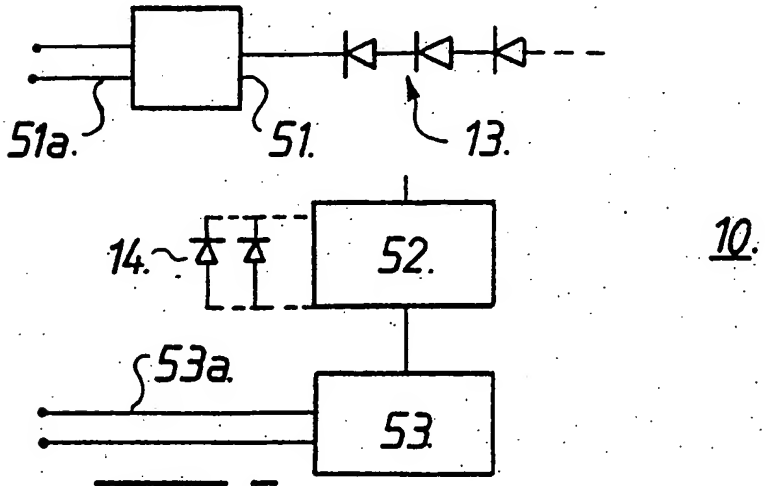

Fig. 5.

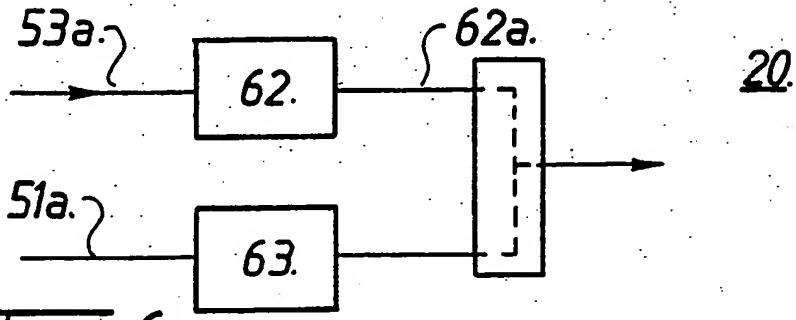

Fig. 6.

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00692

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: H 04 B 10/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	H 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	WO, A1, 8906075 (HM ELECTRONICS, INC.) 29 June 1989, see page 7, line 25 - page 16, line 21; figures 1-4	1-3, 10
Y	--	4-9
Y	DE, C2, 2431937 (SENNHEISER ELECTRONIC KG) 1 April 1982, see column 3, line 41 - column 6, line 36; figures 1-5	4
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Y	DE, A1, 3607885 (PRECITRONIC GESELLSCHAFT FÜR FEINMECHANIK UND ELECTRONIC MBH) 17 September 1987, see column 4, line 12 - line 23; figures 1-2	4
	--	
Y	US, A, 4727600 (E. AVAKIAN) 23 February 1988, see abstract; figure 1	5
	--	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19th February 1991	1991 -02- 21
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Roland Landström ROLAND LANDSTRÖM

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	DE, B2, 2559646 (NEUMANN ELEKTRONIK GMBH) 14 December 1978, see column 2, line 15 - column 4, line 42; figure 1 --	5-8
Y	US, A, 4456793 (W.E. BAKER ET AL) 26 June 1984, see abstract; figure 3 --	5-9
A	DE, B2, 2837907 (SENNHEISER ELECTRONIC KG) 11 September 1980, see column 1, line 31 - column 4, line 15 --	1
A	DE, A1, 2920208 (OTICON ELECTRONICS A/S) 27 November 1980, see page 4, line 1 - page 6, line 11 --	1
A	US, A, 4648131 (T. KAWAGUCHI ET AL) 3 March 1987, see abstract --	1-10

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 90/00692

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 91-01-31
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		US-A-	4882770	89-11-21
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DE-A1- 3607885	87-09-17	NONE		
US-A- 4727600	88-02-23	NONE		
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